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EVALUATION OF ANTI-OBESITY AND DIURETIC EFFECTS OF AQUEOUS EXTRACT OF *TETRAPLEURA TETRAPTERA* TAUB. STEM BARK ON HIGH FAT DIET-INDUCED OBESE RATS

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ABSTRACT

Background: *Tetrapleura tetrapteura* Taub. is a medicinal plant belonging to family of Fabaceae and native to West Africa. Its used in the management of hypertension, diabetes mellitus, and hyperlipidemia. In the present study, the anti-obesity and diuretic effect of the aqueous extract of *Tetrapleura tetraptera* stem bark was investigated in high fat diet induce obese rats. **Methods:** Obesity was induced in rats by using high fat diet for 16 weeks. After induction, animals were treated during 28 days with plant extract at the doses of 100, 200, 400 mg/kg and Orlistat at 5mg/kg. The effect of the treatment was evaluated on food intake, body weight and Lee index. The organ and fat weights were taken. The urinary volume was noted and the urinary electrolytes (K^+, Na^+ and Cl^-) level as well as biochemical parameters and atherogenic index were evaluated at the end of the treatment. **Results:** The oral administration of extract leads to a significant decrease in body weight, fat weight and food intake as well as the serum levels of triglycerides, total cholesterol, LDL-cholesterol, atherogenic and Lee index in the obese animals. Those treated with the doses of 200 and 400 mg/kg of body weight showed significant decreased of these parameters compared to orlistat (standard drug). The evaluation of diuretic effect showed that extract significantly increased the urine output and the urinary electrolytes level in obese animals. **Conclusion:** The aqueous extract of *Tetrapleura tetraptera* stem bark has a protective effect against weight gain, triglycerides, cholesterol and electrolytes retention on high fat diet induce obese rat.

KEYWORDS: *Tetrapleura tetraptera*, obesity, Lee index, electrolytes retention, high-fat diet.

1. INTRODUCTION

Obesity is a metabolic disorder resulting from an abnormal or excessive fat accumulation in adipose tissue.[1] It's the most widespread nutritional problem in the world and its prevalence is still increasing.[2] In 2013, 42 million of children were overweight and obese while, more than 1.9 billion (39%) adults of 18 years old were overweight and 600 million (13%) were obese in 2014.[3] Primarily considered as a disease of the developed countries, obesity is now spread world wide. In Cameroon, it is observed in the rural zones as well as in urban zones.[4] Several measures are used for the managment of obesity including physical activity, diet (includes life behavior), surgical methods and synthetic drugs developed by modern medicine as well as herbal drugs.[5] There are some synthetic drugs that were approved for the treatment of obesity. However, most of them (sibutramine, rimonabant, …) have been withdrawn from the market because of their serious adverse effects.[6] Orlistat is one of synthetic drugs commercialized in pharmacy and used in this study as reference drug. However, Orlistat can result in undesirable side effects, such as fecal incontinence, flatulence, and steatorrhea.[7] Therefore, there is an urgency to find a new way to fight against this uncomfortable life situation. Medicinal plants were presented as an alternative in the management of this disturbance for several raisons; they may contain various naturals compounds (secondary metabolites) with slimming effect or antiobesity activity, they are most of the time more accessible and less expensive than synthetics modern drugs and sometimes present few side effects. In this concern, the slimming effect of some medicinal plants of Cameroonian pharmacopeia,

Laportea ovalifolia, *Brillantaisia vogeliana* was already demonstrated.[8,9] As Concerns *Tetrapleura tetraptera*, few report related to the slimming effet of its stem bark are published.

The fruits of this medicinal plant, belonging to Fabaceae family, are used as spices in West and Central Africa to ameliorate food flavour. It's also used for medicinal purposes such as the treatment of hypertensive disorders, arthritis, inflammatory conditions, epilepsy, schistosomiasis, breast and uterus cancers.[10,11,12] Also, many studies have shown the hypoglycemic, hypolipidemic, hypotensive effects of the plant fruits.[13,14]

The data relating to the hypolidemic effect of *Tetrapleura tetraptera* plant are mentionned only on its fruit. However, ethnobotanical information revealed the use of both stem bark of *Tetrapleura tetraptera* and *Ricinodendron heudoletti* in the management of overweight or obesity (unpublished data). Therefore, it would be possible that the active metabolites present in the fruit of this medicinal plant could also be present in its the stem back. This is what prompted us to undertake the present study during which the anti obesity and diuretic potential of the aqueous extract of *Tetrapleura tetraptera* stem bark (AETT) would be investigated. This would be done by evaluating its effects on anthropometrical and biochemical parameters of the lipids metabolism, urine electrolytes excretion of high fat diet-induced obese rats.

2. MATERIALS AND METHOD

2.1. Chemicals and reagents

Triglyceride, Total cholesterol, HDL cholesterol and transaminases Kits were purchased from INMESCO/Cameroon. Orlistat, purchased from Pharmaceutical industries of Pakistan, was available for oral administration as capsule and each capsule contained a pellet formulation consisting of 120 mg of the active ingredient.

2.2. Collection and identification of plant material

Fresh sample stem barks of *Tetrapleura tetraptera* were collected in the locality of Santchou located in the Menoua Division of the West region of Cameroon during the month of March 2016. The plant was identified and authenticated at the National Herbarium, Yaounde, in comparison with the reference voucher specimen number -1240 (66344/HNC). Moreover stem bark sample was then dried at room temperature, and crushed into powder.

2.3. Aqueous extract preparation

A mass of 1000 g of powder of *Tetrapleura tetraptera* was mixed up with 7 L of distilled water and the mixture was boiled for 15 min. After cooling, the extract was filtered using Whatman paper No. 1. Furthermore the filtrate (AETT) was dried in a ventilated oven at 45°C. The resulting powder (72 g) was considered as our extract with an extraction yield of 7.2% (w/w). From the powder obtained previously, several concentrations of the extracts were prepared (40, 20 and 10 mg/ml) and were daily administered at different doses (400, 200 and 100 mg/kg respectively) to the animals in accordance to their body weight.

2.4. Experimental animals

Albino Wistar rats were used for the experiment. They were bred in the animal house of the Biochemistry Department (University of Dschang), housed under uniform husbandry conditions of light (12-h cycle) and temperature (22 ± 2°C). Some animals were fed with a food which composition was propose by Telefo [15] while others received a high fat diet. All animals received food and tap water *ad libitum.* Experimental protocols used in this study were accepted by the local ethical committee of our Faculty (Faculty of sciences, University of Dschang, Cameroon) and were designed in strict concordance with the internationally accepted standard ethical guidelines for laboratory animal use and care as described in the European Community guidelines; EEC Directive 86/609/EEC, of the 24th November 1986.

2.5. Obesity induction in animals

After the parturition of female rats previously mated with males, pups obtained were weaned at the age of 1 month and submitted to a 22% fatty food with composition described in **Table 1**.

In order to follow the obesity state of animals during the induction period of 16 weeks, their Lee index (IL) were calculated using the body weight and Naso-anal length taken every month.This index was calculated using the equation below.[43] Rats with Lee index higher or equal to 300 (Li ≥ 300) were considered obese.

$$\mathbf{IL} = \left(\sqrt[3]{P}/L\right) \times \mathbf{1000}$$

Table 1: Food composition (gm).

Ingredients	Normal Diet (ND)	High Fat Diet (HFD)
Corn powder	678	576
Soya beans powder	200	170
Fish powder	100	85
Born powder	10	10
Kitchen salt	10	10
Beef Tallow	-	139
Vegetal oïl	1	/
Vitamins	1	10

2.6. Animals distribution and treatment

At the end of the induction period, seventy two (72) rats made of sixty (60) obese and twelve (12) non obese rats. They were randomly divided into 6 groups of 12 animals each (6 males and 6 females). The first group (group 1) was made of normal rats fed with standard diet and they received distilled water. The second group (group 2) was made of obese rats fed with high fat diet and received distilled water. The third group (group 3) was made of obese rats fed with high fat diet and received standard drug (orlistat at 5 mg/kg). The other groups (4, 5 and 6) were constituted of obese rats fed continuously with high fat diet (HFD) and received aqueous extract of *Tetrapleura tetraptera* (AETT) at different doses of 100, 200 and 400 mg/kg respectively for 28 days. The animals were then treated as described below:

- Group 1: Normal diet control (ND).
- Group 2: High fat diet control (HFD)
- Group 3: HFD + Orlistat 5 mg/kg b.w
- Group 4: HFD + AETT 100 mg/kg b.w
- Group 5: HFD + AETT 200 mg/kg b.w
- Group 6: HFD + AETT 400 mg/kg b.w.

2.7. Determination of body weight, lee index and food intake

The above treatment was carried out for 28 days. During this period of treatment, the body weight and length (nose to base of tail) was measured every two and four days respectively to determine Lee index. This index was calculated following the formula mentioned above. The food intake was calculated daily. The evaluation of the average of food intake per rat was recorded daily by subtracting the quantity of remaining food everyday from the initial quantity provided the previous day.

2.8. Evaluation of biochemical parameters and estimation of organs and fats weight

Twenty-four hours after the last treatment (day 29), animals were sacrificed under chloroform anesthesia. Their blood extracted from the heart were collected into test tubes without anticoagulant and allowed to stand for 45 min at room temperature before being centrifuged at 3400 rpm for 10 min to obtain serum. The serum collected was stored at -18°C and used for biochemical analysis. Organs like liver and kidney were collected and weights as well as abdominal and ovary fats.

For lipid profiles estimation, the serum was used for determination of following biochemical parameters: seric level of triglycerides (TG), total cholesterol (TC) and HDL-Cholesterol (HDL-C). These parameters were estimated through colorimetric methods with commercially available test kits according to the manufacturer's recommendations. LDL-Cholesterol (LDL-C) level was estimated by the formula describe by Friedewald [16] (see below).

$$\textbf{LDL-C = TC – [HDL-C+ (TG/5)]}$$

The atherogenic index (AI) was calculated by using the method of Muruganandan and Suanarunsawat [17,18]

Apartate aminotransaminase (ASAT), Alanine aminotransaminase (ALAT) enzymes levels were estimated Via commercial kits according to manufacturer's protocol (DiaLab).

2.9. Evaluation for diuretic activity

Immediately at the end of the treatment period, animals were placed individually in metabolic cages without food or water. The 24h urine volume was collected, measured and conserved at -18°C for analysis of conductivity and assessment of urine electrolytes such as sodium (Na^+), potassium (K^+) and chloride (Cl^-) ion levels. Conductivity of urine sample was estimated using a conductimeter 'WTW model'. Urinary concentrations of Na^+, K^+ and Cl^- were measured using a Jenway model of flame photometer as described by Pauwels *et al*. and Vogel *et al*. [19,20] The diuretic and electrolytes index was also calculated to compare the effects of the test substances to HFD control.

2.10. Statistical analysis

The software GraphPad Prism 5.01 was used for statistical analysis. Results were expressed as mean ± standard error of the mean (SEM). The statistical analysis was carried out using one and two-way analysis (ANOVA) followed by Tukey's Multiple Comparison and Bonferroni's tests respectively. Values with $P < 0.05$; 0.01 and 0.001 were considered statistically significant.

3. RESULTS

3.1. AETT effect on food intake

During the experimental period, male obese rat treated with AETT at doses of 200 and 400 mg/kg showed after 20 days of treatment significant ($P<0.001$) reduction in food intake as compared to HFD control (Fig. 1A). The same trend was noticed earlier with female obese rats where significant ($P<0.001$) reduction of 50.42% and 42.73% in food intake was observed just after 4 day of treatment with 200 and 400 mg/kg of AETT respectively (Fig. 1B). Daily treatment of male obese rat with orlistat (5 mg/kg) resulted in a significant ($P<0.001$) reduction in food intake from day 4 to day 20; while in female, this significant ($P<0.01$ and $P<0.05$) reduction was notice from day 4 until the end of treatment.

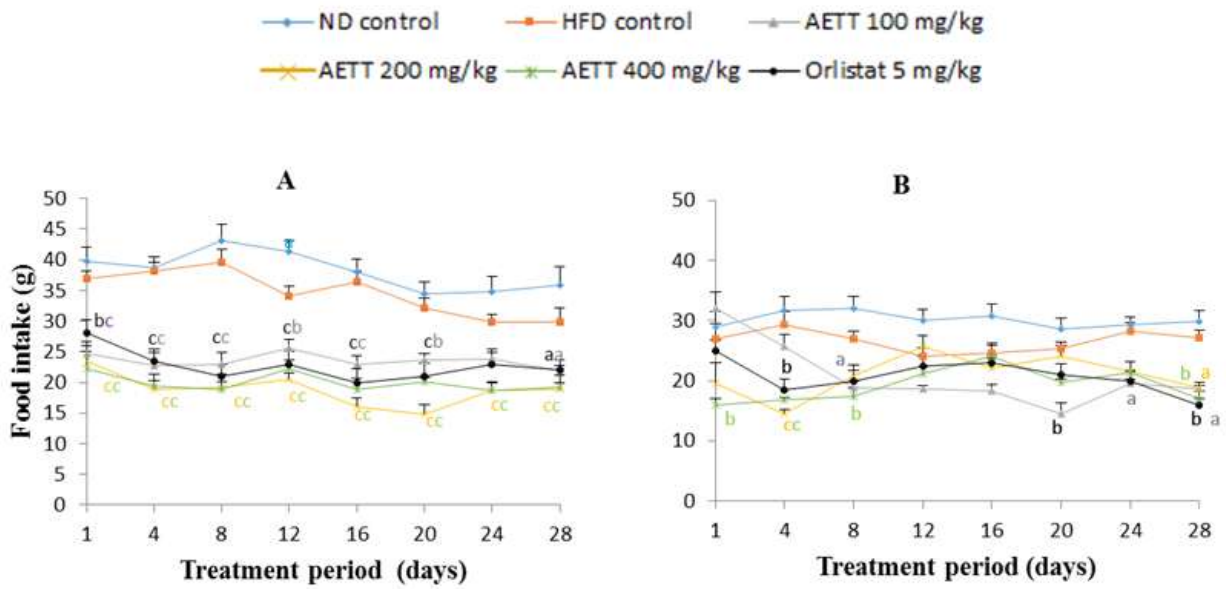

Fig. 1: Effect of daily oral administration of AETT on food intake in male (A) and female (B).

All data are reported as the mean ± S.E.M. for n = 6 per group. ANOVA two way followed by Bonferroni posttest [a]p <0.05, [b]p <0.01 and [c]p <0.001: significant differences compared with HFD control (distilled water). A : male, B: female, ND: Normal diet, HFD: Hight Fat Diet.

3.2. AETT effect on relative body weight

The effects of AETT on relative body weight of treated and control rats are presented in Figure 2). The administration of AETT to male obese rats at doses of 200 and 400 mg/kg significantly (P<0.01 and P< 0.001) decreased the relative body weight of animals from day 8 until the end of treatment as compared to HFD control. Similar results were obtained in male obese rats treated with orlistat (5 mg/kg) when compared to HFD control (Fig. 2A). Female obese rat treated with AETT at all doses (100, 200 and 400 mg/kg) showed a significant (P< 0.05 and P< 0.01) reduction in relative body weight from day 8 to day 28 as compared to HFD control. the same trend was recorded with Orlistat (5 mg/kg) where a significant (P< 0.01 and P< 0.001) reduction in relative body weight was observed from day 16 to day 28 when compared to HFD control (Fig. 2B).

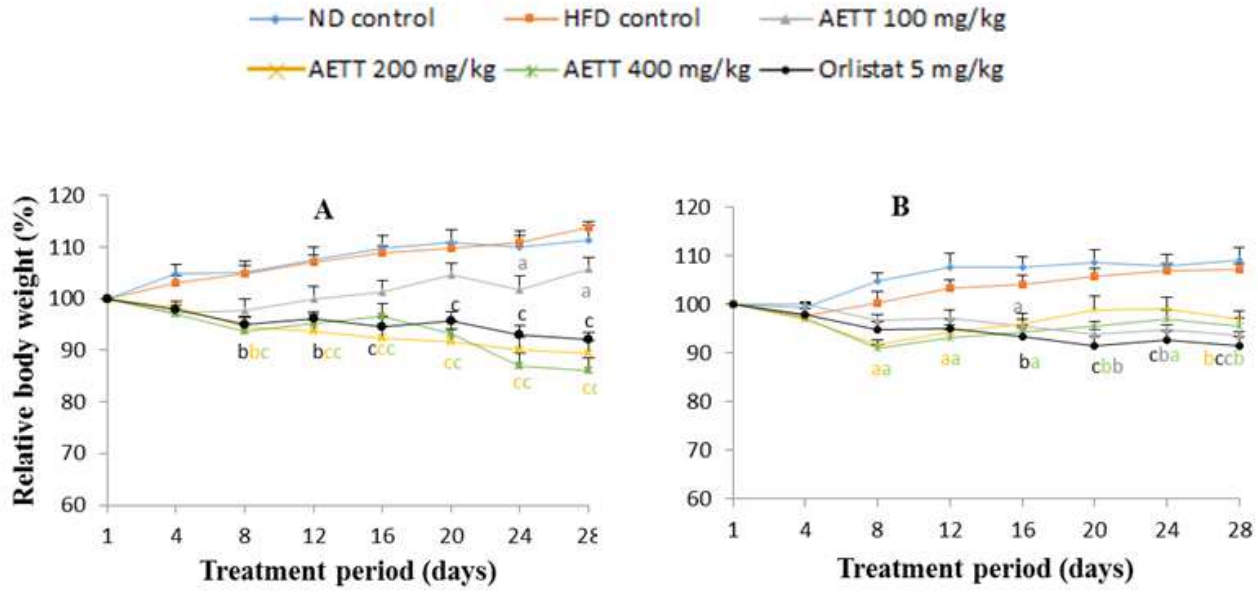

Fig. 2: Effect of daily oral administration of AETT on body weight in male (A) and female (B).

All data are reported as the mean ± S.E.M. for n = 6 per group. ANOVA two way followed by Bonferroni posttest. [a]p <0.05, [b]p <0.01 and [c]p <0.001: significant differences compared with HFD control (distilled water). A : male, B: female, ND: Normal diet, HFD: Hight fat diet.

3.3. AETT effect on Lee index

Results reveal that, male obese rats treated with AETT at doses of 400 and 200 mg/kg showed a significant (P< 0.001) decrease in the Lee index from day 8 to 28 and 24 to 28 respectively. Similar results were observed with the group treated with orlistat (5 mg/kg) from day 16 to 28 as compared to HFD control (Fig. 3A). Concerning females, a significant (P< 0.001) reduction of the Lee index was observed with the dose 400 mg/kg at days 12, 24 and 28 and from day 24 to 28 with the dose of 200 mg/kg. Same results were recorded with orlistat (5 mg/kg) treated group where a significant (P< 0.01 and P< 0.001) reduction in Lee index was observed from day 12 to day 28 when compared to HFD control (Fig. 3B).

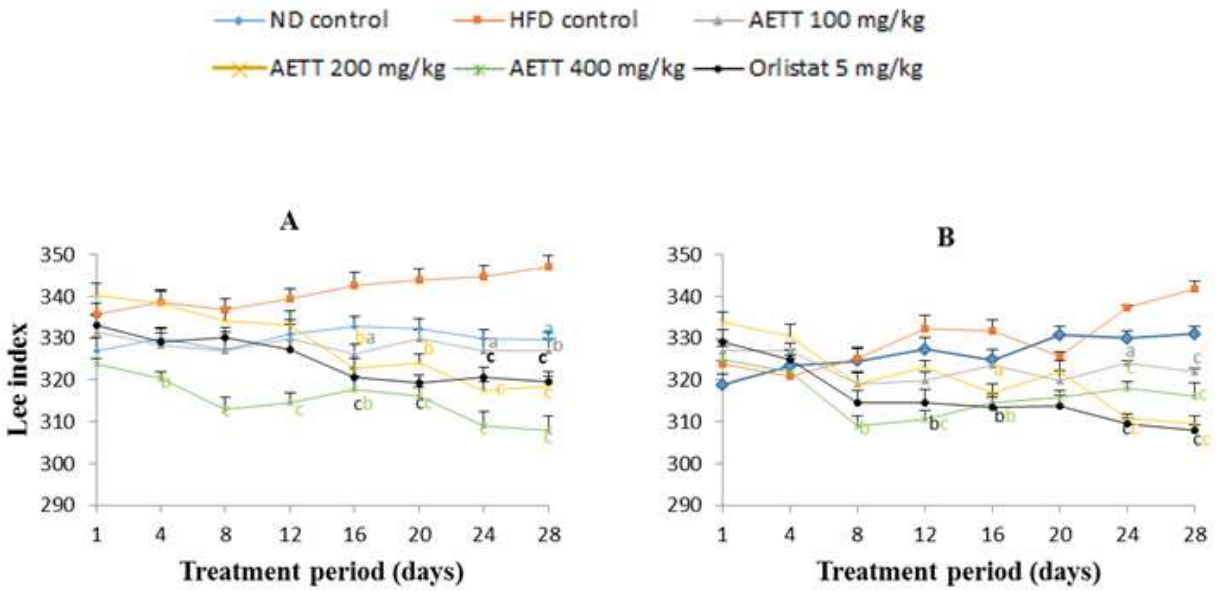

Fig. 3: Effect of daily oral administration of AETT on Lee index in male (A) and female (B).

All data are reported as the mean ± S.E.M. for n = 6 per group. ANOVA two way followed by Bonferroni posttest. [a]p <0.05, [b]p <0.01 and [c]p <0.001: significant differences compared with HFD control (distilled water). A : male, B: female, ND: Normal diet, HFD: Hight fat diet.

3.4. AETT effect on organs and fats weight.

After 28 days of treatment, no significant change in organs weight (liver, kidney and heart) was observed in all treated animals of both sexes when compared to their respective HFD control. Concerning abdominal and ovary fats, a significant (P< 0.001) reduction was observed at all doses as well as orlistat compared to HFD control (Table 2).

Table 2: Effect of administration of AETT on the relative organs and fats weight of male and female rat.

mg/kg	Liver (g)	Heart (g)	Kidney (g)	Abdominal fats (g)	Ovary fats (g)
Male					
ND control	3.05 ± 0.14	0.31 ± 0.01	0.60 ± 0.03	12.56 ± 0.22[c]	
HFD control	2.90 ± 0.23	0.27 ± 0.02	0.59 ± 0.03	15.16 ± 0.20	
HFD + Orlistat 5	3.02 ± 0.06	0.30 ± 0.00	0.57 ± 0.02	9.22 ± 0.34 [c]	
HFD + AETT 100	2.80 ± 0.11	0.28 ± 0.01	0.47 ± 0.02	10.34 ± 0.23[c]	
HFD + AETT 200	2.82 ± 0.07	0.30 ± 0.02	0.55 ± 0.05	9.04 ± 0.31[c]	
HFD + AETT 400	3.16 ± 0.02	0.33 ± 0.02	0.64 ± 0.04	7.17 ± 0.70[c]	
Female					
ND control	3.12 ± 0.08	0.32 ± 0.01	0.64 ± 0.04	10.42 ± 0.33[c]	3.86 ± 0.19[c]
HFD control	3.52 ± 0.37	0.33 ± 0.05	0.68 ± 0.03	12.95 ± 0.33	5.47 ± 0.39
HFD + Orlistat 5	3.13 ± 0.04	0.33 ± 0.01	0.56 ± 0.04	6.55 ± 0.42[c]	1.97 ± 0.16[c]
HFD + AETT 100	2.68 ± 0.03	0.36 ± 0.03	0.55 ± 0.05	6.88 ± 0.31[c]	2.43 ± 0.16[c]
HFD + AETT 200	2.99 ±0.22	0.34 ± 0.03	0.58 ± 0.01	3.98± 0.44[c]	1.68± 0.19[c]
HFD + AETT 400	2.71 ± 0.03	0.29 ± 0.02	0.57 ± 0.01	2.52 ± 0.18[c]	0.70 ± 0.16[c]

All data are reported as the mean ± S.E.M. for n = 6 per group. ANOVA two way followed by Bonferroni posttest. [c]p <0.001: significant differences compared with HFD control (distilled water). ND: Normal diet, HFD: Hight fat diet.

3.5. AETT effect on biochemical parameters and atherogenic index

The effects of AETT on biochemical parameters (TG, Total-C, HDL-C, LDL-C) of treated rats are presented in Fig. 4. The administration of AETT in male obese rat at all doses showed a significant (P<0.001) reduction in the seric level of TG, Total-C, HDL-C and LDL-C when compared to the respective HFD control data (Fig. 4A). Similar results were recorded with female obese rats where a significant (P<0.001) reduction in all parameters was observed, except the dose of 100 mg/kg (Fig. 4B). In both sexes, a significant (p< 0.001) reduction in the seric level of TG, Total-C and LDL-C on rats treated with Orlistat was observed when compare to HFD control.

As Concerns atherogenic index, a significant (p< 0.001) reduction of this parameter was observed in treated male and female obese rats at all the doses as compared to HFD control. Similar results were also observed with control receiving Normal Diet (ND) when compare to HFD control (Fig. 5).

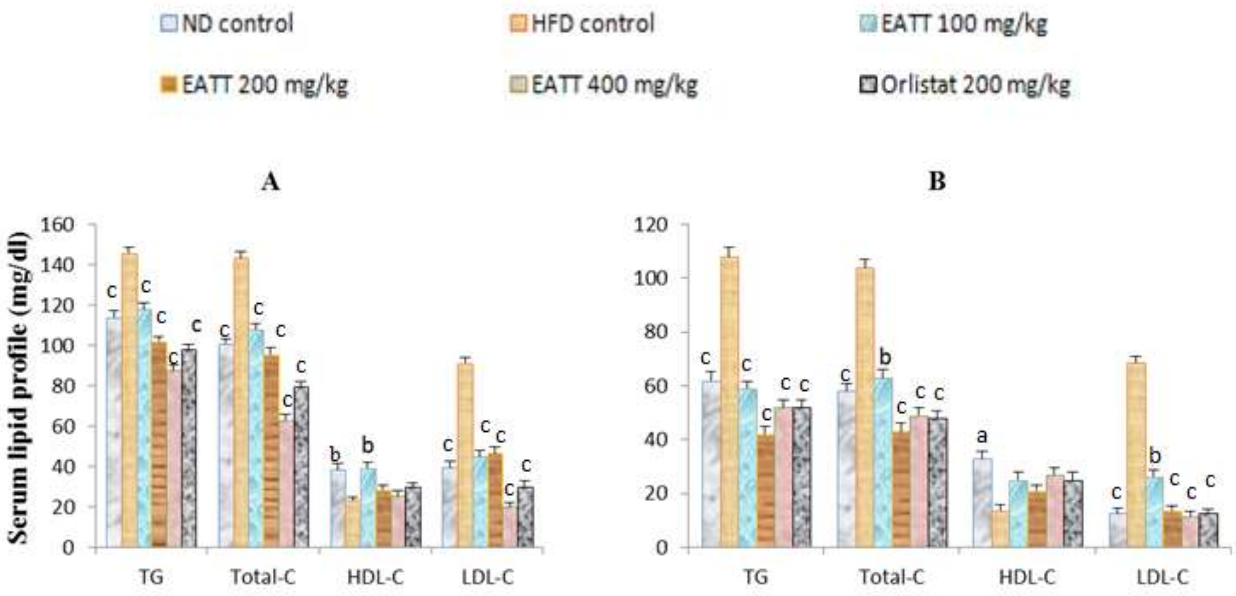

Fig. 4: Effect of daily administration of AETT on some blood biochemical parameters of the lipid profile in male (A) and female (B).

All data are reported as the mean ± S.E.M. for n = 6 per group. ANOVA one way followed by Tukey's posttest . [a]p <0.05 ; [b]p <0.01 and [c]p <0.001: significant differences compared with HFD control (distilled water). A : male, B: female, ND: Normal diet, HFD: Hight fat diet.

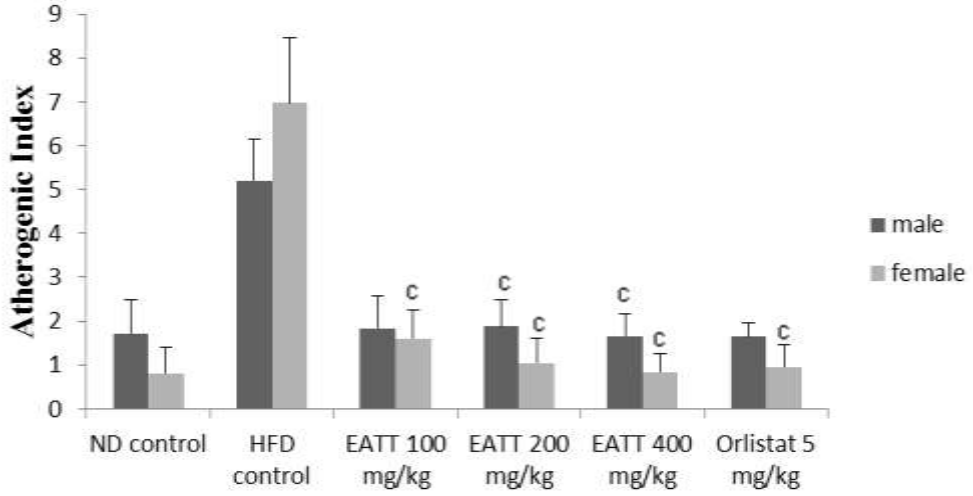

Fig. 5: Effect of daily oral administration of AETT on atherogenic index in male and female.

All data are reported as the mean ± S.E.M. for n = 6 per group. ANOVA one way followed by Tukey's posttest. [c]p <0.001: significant differences compared with HFD control (distilled water). ND: Normal diet, HFD: Hight fat diet.

3.6. Effect of AETT on some enzymatic parameters of liver function in male and female rats

The results on seric transaminases (ALAT and ASAT) in male and female rats are summarized in table 3. In both sexes, a significant (P< 0.05) reduction of ASAT and ALAT was observed on ND control when compared to HFD control while no significant variation in seric ALAT was observed at all doses of plant extract when compared to HFD control. In male obese rat, data revealed a significant (P< 0.05) decrease of seric ASAT (38.71%) at the dose of 400 mg/kg as compared to HFD control.

Table 3: Effect of administration of AETT on liver marker enzymes.

Doses (mg/kg)	ASAT	ALAT
Male		
ND control	35.46 ± 3.27[a]	25.73 ± 2.47
HFD control	54.09 ± 5.21	39.69 ± 4.56
Orlistat 5	38.55 ± 3.04	28.19 ± 3.43
HFD + AETT 100	42.98 ± 4.82	50.81 ± 3.34
HFD + AETT 200	41.97 ± 2.50	24.87 ± 2.42
HFD + AETT 400	33.15 ± 3.37[a]	45.15 ± 3.38
Female		
ND control	33.52 ± 5.12	17.01 ± 3.93[a]
HFD control	55.63 ± 5.03	41.00 ± 4.43
Orlistat 5	35.58 ± 3.77	30.56 ± 1.58
HFD + AETT 100	56.27 ± 5.50	37.95 ± 3.91
HFD + AETT 200	39.73 ± 2.62	24.06 ± 5.08
HFD + AETT 400	48.86 ± 3.96	29.23 ± 4.39

All data are reported as the mean ± S.E.M. for n = 6 per group. ANOVA one way followed by Tukey's posttest. [a]p <0.05: significant difference compared with HFD control (distilled water). ND: Normal diet, HFD: Hight fat diet.

3.7. Evaluation of AETT stem bark on diuretic activity

3.7.1 AETT effect on urine volume

During the experimental period, male obese rats treated with AETT at dose of 400 mg/kg showed, from day 12 to day 16 significant (p< 0.05) increase in urine volume as compared to HFD control (Fig. 6A). In female obese rats, a significant (p< 0.05 to p< 0.001) increase in urine volume were observed at doses of 200 and 400 mg/kg from day 12 to day 28. In both sexes, the results also showed that, the urine volume of ND control group was significantly (p< 0.001) higher from day 1 to day 28 as compared to HFD control data of the respective day.

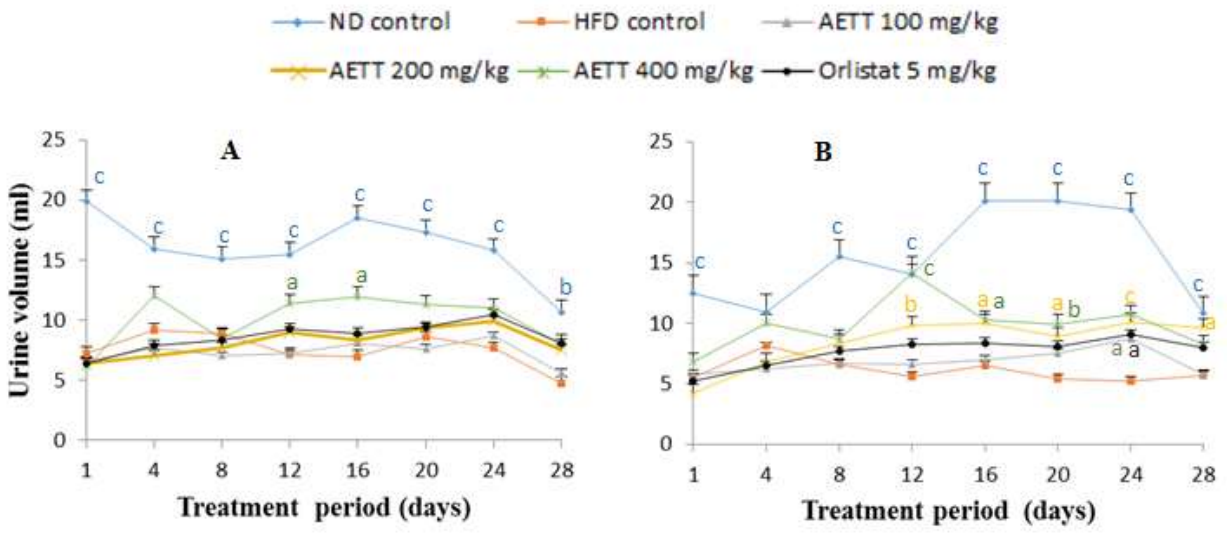

Fig. 6: Effect of *Tetrapleura tetraptera* on urinary volume in male (A) and female (B).

All data are reported as the mean ± S.E.M. for n = 6 per group. ANOVA Two way followed by Bonferroni posttest. [a]p <0.05;[b]p <0.01; [c]p <0.001: significant differences compared with HFD control (distilled water). A : male, B: female, ND: Normal diet, HFD: Hight fat diet.

3.7.2. AETT effect on conductivity

Table 4 represents the effect of *Tetrapleura tetraptera* stem bark aqueous extract on urine conductivity. In both sexes, no significant variation in urine conductivity was observed in all treated groups when compared to HFD control. However, there was a significant ($p< 0.001$) increase in urine conductivity of ND control male when compared to HFD control.

Table 4: Effect of administration of AETT on conductivity in High fat diet-induced obese rats.

Doses (mg/kg)	Conductivity (cm/ms)	
	Male	Female
ND control	123.83 ± 9.31^{c}	83.75 ± 10.54
HFD control	72.60 ± 3.77	61.75 ± 3.03
Orlistat 5	70.76 ± 0.39	64.85 ± 7.71
HFD + AETT 100	67.80 ± 8.27	75.15 ± 4.88
HFD + AETT 200	66.50 ± 1.64	54.50 ± 10.62
HFD + AETT 400	78.53 ± 7.50	64.85 ± 6.01

All data are reported as the mean ± S.E.M. for n = 6 per group. ANOVA one way followed by Tukey's posttest. ^{c}p <0.001: significant difference compared with HFD control (distilled water). ND: Normal diet, HFD: Hight fat diet.

3.7.3. AETT effect on urinary electrolyte excretion

The effects of different doses of AETT or orlistat on urinary electrolyte (Na^+, K^+ and Cl^-) excretion in both obese and normal rats are presented in Table 5. The results show that, in male and female obese rat, a significant ($p< 0.001$) increased was observed with Cl^- (34.66% and 43.84%) at the dose of 400 mg/kg when compared to the respective gender HFD control. Similar results ($p< 0.01$ and $p< 0.05$) were observed, at the dose of 100 mg/kg, in female obese rats with urine K^+ and Cl^- respectively. Relatively to urine Na^+, a significant ($p< 0.05$) increase was recorded in male obese rats receiving the dose of 400 mg/kg when compared to HFD control. Furthermore and comparatively to HFD control, urinary Na^+, Cl^- and K^+ electrolyte excretion were significantly ($p< 0.001$ and $p< 0.01$) increased in male rats receiving Normal Diet, whereas in female obese rats a significant ($p< 0.001$ and $p< 0.05$) increase was observed only with Cl^- and Na^+.

Table 5: Effect of administration of AETT on urinary electrolytes level of controls and treated obese rats.

Doses (mg/kg)	Na^+ (mg/l)	K^+ (mg/l)	Cl^- (mg/l)	Na^+ Index	K^+ Index	Cl^- Index
Male						
ND control	761.25 ± 12.29^{c}	2380 ± 22.24^{b}	$815.17 \pm 13{,}09^{c}$	1	1	1
HFD control	343.50 ± 6.70	1684.75 ± 14.03	$402.58 \pm 9{,}70$	0.45	0.71	0.49
Orlistat 5	$367.07 \pm 11{,}02$	$1905.54 \pm 13{,}52$	$365.77 \pm 19{,}02^{b}$	1.07	1.10	0.94
HFD + AETT 100	330.25 ± 8.13	1626.25 ± 21.06	377.80 ± 9.16	0.96	0.68	0.94
HFD + AETT 200	398.50 ± 8.59	1899 ± 13.50	378.55 ± 11.21	1.16	1.13	0.94
HFD + AETT 400	501.25 ± 10.57^{a}	2171.75 ± 18.84	542.13 ± 10.17^{c}	1.46	1.29	1.35
Female						
ND control	624.50 ± 09.19^{a}	1959.5 ± 19.24	821.18 ± 13.09^{c}	1	1	1
HFD control	386.5 ± 11.02	1527 ± 12.09	368.15 ± 19.02	0.62	0.78	0.45
Orlistat 5	$589.00 \pm 11{,}20$	$2061.50 \pm 12{,}13$	394.83 ± 9.70^{b}	0.97	1.11	1.07
HFD + AETT 100	431.00 ± 9.13	2358.00 ± 18.06^{b}	383.25 ± 9.16^{a}	1.11	1.54	1.04
HFD + AETT 200	407.50 ± 7.98	$2094.00 \pm 11{,}20$	368.50 ± 11.21	1.05	1.37	1
HFD + AETT 400	589.00 ± 8.57	2061.50 ± 15.24	529.55 ± 10.17^{c}	1.52	1.35	1.45

All data are reported as the mean ± S.E.M. for n = 6 per group. ANOVA one way followed by Tukey's posttest. ^{a}p <0.05; ^{b}p <0.01; ^{c}p <0.001: significant differences compared with HFD control (distilled water). ND: Normal diet, HFD: Hight fat diet

4. DISCUSSION

Obesity is characterized by increased adipose tissue mass that result from both increase in fat cell number and fat cell size to the level which might have a negative effect on health.[21] It is also a direct consequence of perpetual imbalance between energy intake and expenditure with storage of extra calories in the form of fat in the adipose tissue.[22] Many studies indicated that HFD-induced obesity in rodents are considered to be a good model as they have reported to bear close resemblance to human obesity.[23] In the present study, HFD model was used to induce obesity in wistar rats in order to evaluate the antiobesity and diuretic activities of aqueous extract of *Tetrapleura tetraptera* (AETT). Anthropometric factors constitute the important markers of obesity diagnosis. Among these factors, body weight, food intake and Lee index were evaluated in this work. The results revealed that, oral administration of AETT significantly reduced food intake, body weight and Lee index in the experimental rats as compared to HFD control. The

reduction in food intake during the treatment could be due to the suppression of appetite, which can explain the body weight loss. Similar results were recorded with the leaves extracts of *Aegle marmelos, Zingiber officinale* and *Terminalia paniculata* where the decrease in food intake is explained by the increase in the expression of lipolytic proteins or inhibition of lipogenesis by reduced expression of fatty acid synthase and related enzymes. [23,27,28] This reduction was also similar to Orlistat, known to induce weight loss in obese subjects via inhibition of gastric and pancreatic lipase and reduction of the absorption of dietary fat (up to 30%).[24,27]

The significant reduction in the Lee index observed in the treated animals could be related to the loss in AETT treated animal body weight as previously described. The work of Gbadamosi and Yekini[29] have shown the presence of active compounds such as tannins, phenols, saponins, alkaloids and flavonoids in the stem bark and fruits of *Tetrapleura tetraptera*, some of which (flavonoids and saponins) are known to possess slimming effect.[30,31] The slimming ability of these phytochemicals could be due to their capacity to activate thermogenesis or inhibit pancreatic lipase.[32] The plant might also contain phenolic compounds capable of inhibiting the intestinal lipase and thereby slowing the absorption of lipids at the level of the intestines. These lipids will then be eliminated in the feces.[33] Adipose tissue plays a major role in fat storage. Accumulation of excessive fat in adipocytes is the underlying phenomenon for obesity.[25] It is reported that high fat diet induces increase in deposition of fat in the mesenteric, perirenal and uterine region in wistar rats. [28] The present results showed that abdominal and ovary fat were significantly reduced in all treated groups as compared to HFD control indicating potential lipid lowering activity of the tested substances. The decrease in the fat weight may be also justify by reduced formation of new adipocyte from precursor cells (adipocyte differentiation) or decreased adipocyte size due to fat storage. [27]

Dyslipidemia is another important hallmark in the pathogenesis of obesity characterized by hypertriglyceridemia with decreased in LDL and VLDL seric levels.[34] It is well documented that HFD induced high triglycerides, total cholesterol or LDL concentrations that are a risk factor for insulin resistance and coronary heart diseases. Indeed, these blood lipoproteins metabolites could in some circonstance build-up plaque in the artery that may lead to narrowing or complete blockage of vessel.[13,23] In the present study, a significant reduction in the seric levels of triglycerides, total cholesterol, LDL and a significant increased in the level of HDL were observed after the administration of AETT in rats feed with HFD. The reduction in seric level of triglycerides registered could be explain by the presence in the plant extract of phenolic compounds that may act as inhibitor of fatty acid synthase and acetyl CoA carboxylase, enzymes involved in lipogenesis and therefore inhibit the accumulation of fats in adipose tissue.[25,26] The reduction of total cholesterol level may be due to the presence of phyto-active constituents such as saponins, alkaloids and flavonoids able of inhibiting the activity of HMG CoA reductase which plays a very important role in the synthesis of cholesterol.[36,37] Similar results were obtained by Bella *et al.*[13] where treatment with aqueous extract of *Tetrapleura tetraptera* stem bark led to an increased level of seric HDL level and decreased level of total cholesterol, LDL, and triglycerides in high salt-sucrose induced hypertensive rat.

Liver function tests are important indicators that reveal the functional status of liver since it is the vital organ involved in detoxification of compounds and metabolism in general. During diet induced obesity, the liver of obese rats displayed characteristic features of hepatic steatosis such as fat accumulation and swelling of rough endoplasmic reticulum and mitochondria in hepatocytes.[38] In this study, there was no variation in hepatic transaminases of AETT treated groups except at the dose of 400 mg/kg where the hepatic enzyme ASAT was significantly reduced. This result may be related to polyphenols that are known to alleviat liver damage. Similar result was observed with Mopuri *et al.*[23] who demonstrated that, the ethanolic extract of *Terminalia paniculata* bark reduced the seric level of AST.

It is reported that obesity is strongly related to bladder dysfunction[44] and which can result to the disturbance of the secretion of electrolytes and urine. In the present study, obesity induction through high fat diet administration induced an increase in body weight couple to reduction in urinary volume and electrolytes excretion (Na^+, K^+ and Cl^-). This result is similar to the observation made by Mohd[39] whose studies showed a decrease in urine volume in rats fed with high fat diet when compared to those fed with normal diet. Indeed, study of Kotsis *et al.*[40] showed that excess body fat activate angiotensinogen production which can then be transformed into angiotensin II by renin. The higher production of angiotensin II causes water retention and tubular reabsorption of sodium and chlorides ions. Administration of the AETT in obese rats increased their ability to eliminate water. This increase could be justified by the presence of metabolites such as saponins, tannins, sterols and phenolic compounds in the extract which would act as mentioned above. Oral administration of AETT for 4 weeks significantly increased electrolytes excretion in obese rats justifying the natriuretic and kaliuretic effect of the extract; this could also be attributed to the presence of saponins and flavonoids in the extract. These phyto-active constituents could act by inhibiting tubular reabsorption of water and electrolytes avoiding therefore an increase in urine volume and stimulation of initial vasodilatation.[41,42]

5. CONCLUSION

From the present study it can be concluded that the aqueous extract of *Tetrapleura tetraptera* stem bark is beneficial for the management of obesity. It also has a beneficial effect on urinary and electrolytes excretion in obese animals. Therefore, the aqueous extract of *Tetrapleura tetraptera* has a protective effect against weight gain, triglycerides, cholesterol and electrolytes retention on obese rats induce by high fat diet.

Conflict of interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

REFERENCES

1. **Fouda AAB, Lemogoum D, Owona JM, Dissongo J, Tobbit RDF, Ngounou MG, Sume E. and Kollo B.** Epidémiologie de l'obésité en milieu du travail à Douala, Cameroun. *Review Medicine of Bruxelles*, 2012; 33: 131-7.
2. **Lau DCW.** Synopsis of the Canadian clinical practice guidelines on the management and prevention of obesity in adults and children. Can Med Assoc, 2006; 176: 1103-6.
3. **WHO.** European ministerial conference of WHO on the fight against obesity. "Obesity and overweight 22 November; 2015; URL: http://www.who.int/mediacentre/factsheets/fs311/en/
4. **Ngogang J, Raisonnier A, Manguele MA, dikoum B, Tantchou J. and Muna WFT.** Obésité et métabolisme lipidique chez la femme camerounaise vivant en zone urbaine. Cardiologie tropicale, 1988; 14: 17-26.
5. **WHO.** European ministerial conference of WHO on the fight against obesity, 2007.
6. **Powell AG, Apovian CM, Aronne LJ.** New drug targets for the treatment of obesity. Clin. Pharmacol. Ther., 2011; 90: 40–51.
7. **Zhang J, Kang MJ, Kim MJ, Kim ME, Song JH**. Pancreatic lipase inhibitory activity of Taraxacum officinale in vitro and in vivoNutr Res Pract, 2008; 2(4): 200-3.
8. **Nzeugeum KWM, Dongmo MOL, Lienou LL, Telefo PB.** Effect of *Laportea ovalifolia* (Urticaceae) on Monosodium Glutamate Induced Obese Rats. African Journal of Integrated Health, **2015**; 5: N°2. P6.
9. **Soh OAV, Mathieu N, Amadou F, Anatole CP, Jeanne NY.** Toxicological studies of the aqueous extract from *Brillantaisia vogeliana* (NEES) BENTH. (Acanthaceae). International research journal of pharmacy, 2012; 3(8): 2230-8407.
10. **Ojewole JAO, Adasina SK.** Cardiovascular and neuromuscular actions of scopotein from fruit of *Tetrapleura tetrapteura*. Planta Med., 1983; 49: 99-102.
11. **John AO and Clement OA.** Anti-inflammatory and hypoglycaemic effects of *Tetrapleura tetraptera* (Taub) [fabaceae] fruit aqueous extract in rats, J. Ethnopharmacol, 2004; 95: 177–182.
12. **Aladesammi, JA.** *Tetrapleura tetraptera*: Molluscicidal activity and chemical constituents: A review, Afr. J. Trad. Complement. Altern. Med, 2007; 4: 23-36.
13. **Bella M, Ngo T, Aboubakar B, Tsala D, Dimo T.** Aqueous extract of *Tetrapleura tetraptera* (mimosaceae) prevents hypertension, dyslipidemia and oxidative stress in high salt-sucrose induced hypertensive rat. Pharmacologia, 2012; 3(9): 397-405.
14. **Kuate D, Kengne P, Biapa P, Azantsa G, Wan A, Manan BWM.** *Tetrapleura tetraptera* spice attenuates high-carbohydrate, high-fat diet-induced obese and type 2 diabetic rats with metabolic syndrome features. Lipids in Health and Disease, 2015; 13p.
15. **Telefo P. B., 1998.** Contribution à l'étude des plantes médicinales du Cameroun: Influence du mélange des feuilles de Aloe Buttneri A. Berger (Liliacées), Dicliptera verticillata GJH Amshoff (Acanthacées), Hibiscus macranthus Hochst ex A-rich (Malvacées), Justicia insularis T Anders (Acanthacées), sur certains paramètres biochimiques et physiologiques de la reproduction chez la rate. Thèse de Doctorat de 3e cycle en Biochimie, Université de Yaoundé I 154 P.
16. **Friedewald WT, Levy RI. and Frederickson DS.** Estimation of the concentration of low- density lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. Clinical Chemistry, 1972; 18: 499-502.
17. **Muruganandan S, Srinivasan K, Gupta S**. Effect of mangiferin on hyperglycemia and atherogenicity in STZ diabetic rats. J Ethanopharmacol, 2005; 97: 497–501.
18. **Suanarunsawat T, Ayutthaya WDN, Songsak T, Rattanamahaphoom J**. Anti-lipidemic actions of essential oil extract from Oscimum sanctum L. leaves in rats fed with high fat cholesterol diet. J Appl Biomed, 2009; 7: 45–53.
19. **Pauwels JM, Van E, Verloo M, and Mvondo ZAD.** Manuel de Laboratoire de pédologie. Publications Agricoles N° 28. Bruxelles. AGCD, 1992.
20. **Vogel HG, Vogel WH, Scholkens BA, Sandow J, Muller G.** Drug Discovery and Evaluation: Pharmacological Assays. Johann Wolfgang Goethe Universität: Frankfurtam Main, Germany, **2008.**
21. **Patra S, Nithya S, Srinithya B. and Meenakshi SM.** Review of Medicinal Plants for Anti-Obesity Activity. iMedPub Journals, Translational Biomedicine, **2015;** 6(3): 21.
22. **Jackson M, Walker S, Cruickshank JK, Sharma S, Cade J, Mbanya J-C, Younger N, Forrester TF. and Wilks R.** Diet and overweight and obesity in populations of African origin: Cameroon, Jamaica and the UK. Public Health Nutrition, 2006; 10(2): 122–130.
23. **Mopuri R, Muniswamy G, Kruthika SB, Brahma NP. and Balaji M.** Evaluation of anti-obesity

activities of ethanolic extract of Terminalia paniculata bark on high fat diet-induced obese rats. BMC Complementary and Alternative Medicine, 2015; 15-76.

24. **Hanan MA, Nagy ST, Bahaa KAH. and Marwa SAL.** Anti-Obesity Potential of Orlistat and Amphetamine in Rats Fed on High Fat Diet. Middle East Journal of Applied Sciences, 2015; 5(2): 453-461.
25. **Padmaja TK, Parim BN, Ghali EN, Hanuma K, Saravanan G, Meriga B.** Antiobesity Activity of *Bauhinia purpurea* Extract: Effect on Hormones and Lipid Profile in High Calorie Diet Induced Obese Rats. Advances in Bioscience and Biotechnology, 2014; 5: 861-873.
26. **Raghu MRP, Jyothi Y. and Syed IR.** Anti-obesity activity of Taraxacum officinale in high fat diet induced obese rats. Journal of Chemical and Pharmaceutical Research, 2015; 7(4): 244-248.
27. **Ankur G. and Randhir S.** Antiobesity Activity of Aqueous and Ethanol Extracts of Aegle Marmelos Leaves in High Fat Diet Induced Obese Rats. Int. J. Pharm. Sci. Rev. Res., 2015; 30(1): 53-60.
28. **Iram N, Ansari SH, Poonam A, Adil A. 2012**. Antiobesity activity of Zingiber officinale. Pharmacogn. J., 2016; 8(5): 440-446.
29. **Gbadamosi I. and Yekini A**. Free radical scavenging activity of different parts of *Tetrapleura tetraptera* (Schumach. And Thom.) Taub. Botany Research International, 2016; 9(1): 01-05.
30. **Zheng T, Shu G, Yang Z, Mo S, Zhao Y, Mei Z.** Antidiabetic effect of total saponins from Entada phaseoloides (L.) Merr.in type 2 diabetic rats. Journal of Ethnopharmacology, 2012; 139(3): 814–21.
31. **Chen F, Xiong H, Wang J, Ding X, Shu G, Mei Z.** Antidiabetic effect of total flavonoids from *Sanguis draxonis* in type 2 diabetic rats. Journal of Ethnopharmacology, 2013; 149(3): 729–36.
32. **Anbarasi B, Parimala D, Balasubramaniyam BP, Senthil KN.** Anti-Obesity Activity of *Zizyphus jujuba* Lam. in Female Rats Fed on High Fat Diet. International Conference on Medical, Biological and Pharmaceutical Sciences, 2012; 29(2): 78-80.
33. **Sarath C, Jyothi Y, Syed IR.** To study the role of exercise and dietary manipulation in obese rats treated with orlistat. International journal of pharmacy and pharmaceutical sciences, 2015; 7(7): 335-339.
34. **Haley AP, Gonzales MM, Tarumi T, and Tanaka H**. Dyslipidemia links obesity to early cerebral neurochemical alterations. Obesity, 2013; 21(10): 2007–2013.
35. **Samy E. and Hussein FS.** Effect of Exercise and Orlistat Therapy in Rat Model of Obesity Induced with High Fat Diet. Med. J. Cairo Univ., 2013; 81(2): 59-67.
36. **Zarei A, Ashtiyani S, Rasekh F, Asghar MA, Gabari A.** The effects of Physalis alkekengi extract on lipids concentrations in rats. Persian. Arak Medical University Journal, 2011; 14(55): 36-42.
37. **Sharma SB, Nasir A, Prabhu KM, Dev G.** Murthy Hypoglycemic and hypolipidemic effect of ethanolic extracts of seeds of Eugenia jambolana in alloxan-induced diabetic model of rabbits. Journal of Ethnopharmacology, 2003; 85: 201-206.
38. **Das N, Sidkar K, Santinath G.** Leaf extract of *Moringa oleifera* Lam. prevents early liver injury and restores antioxidant status in mice. Indian J Exp Biol., 2012; 50: 404–112.
39. **Mohd.** Influence of Dietary Rocket Leaves on Diuresis and Urinary Electrolytes Excretion in High Fat Diet-Induced Obese Rats. Bulletin of Environment, Pharmacology and Life Sciences, 2015; 4(11): 09-13.
40. **Kotsis V, Stabouli S, Papakatsika1 S, Rizos Z. and Parati G.** Mechanisms of obesity-induced hypertension. Hypertension Research, 2010; 33: 386–393.
41. **Martin-Herreraa D, Abdalaa S, Benjumeaa D. and Gutierrez-Luis J**. Diuretic activity of some Withania aristata Ait. Fractions. Journal of Ethnopharmacology, 2008; 117: 496-499.
42. **Wubshet H. and Ephrem E.** Evaluation of the diuretic activity of the aqueous and 80% methanol extracts of *Ajuga remota* Benth (Lamiaceae) leaves in mice. BMC Complementary and Alternative Medicine, 2014; 14: 135.
43. **Bernardis LL, Patterson BD.** Correlation between 'Lee index' and carcass fat content in weanling and adult female rats with hypothalamic lesions. Journal of Endocrinology, 1968; 40: 527-528.
44. **Daneshgari F, Liu G, Birder L, Hanna-Mitchell AT, Chacko S**. Diabetic bladder dysfunction: current translational knowledge. Journal of Urology, 2009; 182: S18–S26.